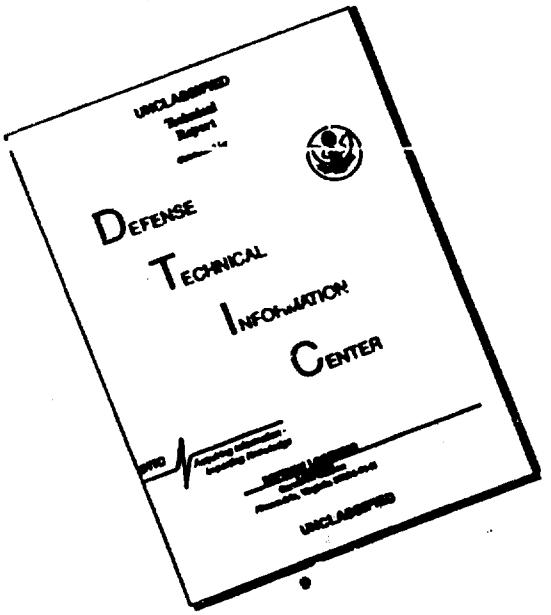
DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

63-2-4

INFRA-RED and ELECTRO-OPTICS

BEC 4278-SA-1

BARNES ENGINEERING COMPANY
30 Commerce Road
Stamford, Connecticut

SEMI-ANNUAL REPORT

PROJECT DAZZLE

Black Knight Reentry Physics Program

Submitted To:

AMICOM/BPD Under Contract No. DA 19-020-ORD-5703
Barnes Contract No. 4278

Field Research and Systems Department

APPROVED BY:

Abe L. Pogoda
Project Manager

PREPARED BY:

Edward W. Skalandunas
Project Engineer

January 14, 1963

ILLUSTRATIONS

TABLE OF CONTENTS

1. INTRODUCTION

The report is intended to show the progress of Barnes Engineering Company covering the period of July 1, 1962 through December 31, 1962 in their capacity of prime contractor to the Army Missile Command and Boston Procurement District under Contract No. DA 19-020-ORD-5703.

Barnes Engineering Company has, since late 1960, provided instrumentation and engineering support to the Australian Black Knight Reentry Physics Program utilizing instrumentation from the American "Project Gaslight" program, the earlier program being sponsored by ARGMA/ARPA, and currently by AMICOM/ARPA.

In January 1962, a request was received for a proposal which would expand and sophisticate the program under the code name "Project DAZZLE". The prime areas affected were: the target tracking capability; a data recording system compatible with computer processing; and an increase in the compliment of data gathering instrumentation.

An addendum to the original proposal was submitted in May 1962, which proposed the use of two Government Furnished Nike-Ajax Target Tracking Pedestals and two trailer mounted tracking stations. The pedestals were to be modified to carry an operator in azimuth, and the sensing instruments in azimuth and elevation.

Included also were modifications which would enable the pedestal to operate in a co-operative optical/radar mode. Synchros and associated circuitry will be added to allow the pedestal to be slaved by remote synhros inputs as well as provide synchro output information for the slaving of remote units. Barnes Engineering Company is working closely with Stanford Research Institute in closing the servo loop around one of the two optical systems and a radar system for the Mount Eba site.

The vans were to be modified to house the electronics and recording system. Support equipment for the Nike system such as motor generator units, boresight telescopes, mobile undercarriage and interconnecting cabling were also requested.

The data recording system was to include time sharing multiplex and magnetic tape recording in addition to chart-pen recorders.

Additional instrumentation included an infrared tracker, high resolution camera consisting of an 80-inch F/8 optical system on a 70mm format, an optical tracking sight with superimposed early acquisition radar position information, wide angle boresight camera and modifications to the existing Project Gaslight instrumentation at the Woomera Range. This instrumentation was to be returned to BEC, Stamford for refurbishing. A contract covering the proposed system was signed and became effective June 29, 1962.

2. TECHNICAL PROGRESS

2.1 Pedestal Modifications:

2.1.1 Instrument Platform or Elevation Carriage:

During the intervening weeks between the signing of the contract and receipt of the Nike-Ajax systems, a modification program was planned for the Nike-Ajax van and pedestal using Army technical manuals and AMICOM supplied drawings. To supplement this information, several trips were made by various technical personnel to Letterkenny Ordnance Depot and to de-activated site locations where the two GFE systems were to be acquired. Telephone discussions were also held with technical personnel of Bell Laboratories and Western Electric, designers and manufacturers of the Nike-Ajax system.

Following a lengthy period of communication with AMICOM, BPD, Letterkenny Ordnance Depot, and the de-activated site, the two systems arrived at BEC, Stamford. This occured between the 18th and 24th of September. Figure 3 shows the systems as they arrived at BEC. Following a short period of familiarization, a series of tests were undertaken to determine the veracity of the preliminary studies. Figure 5 shows a view of the pedestal fitted with an outrigger to determine the effects of off-axis loading.

The tests indicated that a more sound approach would be to place the manual tracking operator within the yoke, and redesign the elevation carriage. This had been considered as an early possibility, but is now to be the basic philosophy of the man/machine system. Figure 2 shows pictorial view of this configuration.

The elevation carriage has been designed to accommodate a number of instruments by utilizing detachable equipment shelves. For example, the Mount Eba pedestal is currently supporting six (6) instruments plus an electronics amplifier module housing. Additional instruments may be added, the number, of course, depending on dimensions and weight.

Magnesium castings are being used for the elevation carriage, shafts, and instrument shelves. This is intended to reduce the weight and still maintain a rugged structure with minimum warp or distortion characteristics.

The existing data units on the Nike-Ajax pedestals are to be modified to accept additional synchros and the linear potentiometers. They will be placed in the model shop as soon as the specifications on the added gears have been determined. The synchros will be used to provide slaving information and the input

information to the acquisition sight. The potentiometers will be used to give absolute position information. It is anticipated that they will be ready for installation on the pedestals beginning the first week of February.

2.1.2 Manual Operator Accommodations:

The manual operator is housed in a protective shroud approximately on the axis of azimuth rotation. This places the man in an ideal location adding minimum inertia in azimuth. An adjustable seat will allow the operator to select a position most suitable to himself. He will not move in elevation.

Tracking will be through an open reflex sight with superimposed, infinity focused, images of a fixed reticle and the radar position indicator.

The joystick console will be at a comfortable position for manual operation. The console will be mounted so as to pivot out away from the seat when the operator is entering or leaving the seat. Moving the console away from the operating position opens one of three pedestal disable switches. The disable switches remove plate voltage from the high power servo amplifiers, ensuring operator safety. The other two disable switches are on the base of

the pedestal and in the van. A light indication in the van signifies pedestal energized or disabled for surveillance by the test co-ordinator.

The casting of the yoke portion on the pedestal has approximately a 14° slope from the center to the edge. A flooring arrangement has been designed to provide a level walking area for the operators who require access to the tracking operators seat, to boresight the instruments or load film into the cameras. The instruments located at the top of the elevation carriage will be accessable by way of a ladder arrangement. Preliminary fitting of the flooring is to begin the fourth week of January.

2.2 Van Modifications:

Shortly after the systems arrived at BEC, work was under way to remove all consoles and chassis that would not be used. This included interconnecting, cabling, and bulkhead connectors. The two main consoles that were retained are the power supply cabinet and the target tracking radar control console.

The TTR console is to be the control point for the optical system. This station will be manned by the operations coordinator. He will be in a position to tell at a glance, by observing the control panel, the operational status of each instrument as well as the track mode of the pedestal. He will be the focal point for communications between his respective site, and all remote locations. Figure No. 4 shows a plan view of the van.

All electronic chassis installed in the vans will be mounted in the five in-line equipment bays. To facilitate maintenance and installation, it is possible to move the entire five bay assembly as a unit while it is either in or out of the van without disconnecting any of the cabling. All interconnecting bay cabling will be through a wiring trough which is mounted in the base of the assembly. The cabling connecting the electronics van with the pedestal will be through

van bulkhead connectors. Channeling is being fabricated to be installed in the floor of the van. This will act as a guide for castors in the base, so that the bay assembly can be moved forward and returned to its original position. An air conditioning duct at the top of the assembly and an opening in the base will allow the air-conditioned cooling system to circulate air through each bay.

Further, modifications including flooring, lighting, and interior painting will be completed the second week of February.

2.3 Recording System:

One of the major additions to the program is the means of recording data. This is to be accomplished by chart-pen recorders that were available as furnished equipment from Weapons Research Establishment Woomera, and a time division, or time sharing multiplex system fabricated according to specifications provided by WRE. Following a period of correspondence with WRE to finalize the specifications, a contract was let in mid-August. Data Control Systems received the contract for two time sharing multiplex systems. BEC provided the magnetic tape recorders and equipment bays which housed the systems.

The multiplex system has been designed to provide 24 channels of commutated information plus 24 channels of subcommutated information. The subcommutation channels are connected to channel number two of the main commutator, thus providing a total of 47 available data channels. The main commutator is operating at a rate 100 samples/sec., subcommutator 4 samples/sec. The photomultipliers and radiometers which are providing the information to be recorded on this system are being commutated and supercommutated. A request was made early in the program to change the sample rate of these instruments so as to provide a means of extending their recorded dynamic range. For example, photomultiplier channel number one had been assigned to four

commutator switches, thus providing a 400 sample rate per second. This would all be recorded at a fixed attenuation level. However, during a trial, if the data exceeded the attenuation setting of the amplifier, there would be no visible means of monitoring that a saturation point had occured. It was decided that two amplifiers with a fixed attenuation factor between them could be used. This could be recorded by connecting one amplifier output to two of the switches and also the attenuated output to two different switches. Individually this would give a rate of 200 samples/sec., but over all would still provide a sample rate of 400 per second, but would increase the dynamic range by 5, 10, 20, or which ever factor is decided on.

During the development stage of the systems, the question arose numerous times concerning the sync frequencies of 85kc on channel 1.1 of the main commutator and 77kc on channels 2.1 and 2.2 of the subcommutator. The indecision was due to what appeared to be conflicting specifications. The original specifications called out a center frequency of 60kc ±25kc deviation with sync frequencies at 91kc and 82kc. This was beyond the +25kc deviation upper limit. A request for confirmation of this resulted in a revision of the center frequency to 50kc ±15kc deviation, with sync frequencies of 85kc and 77kc. These frequencies were now beyond the +15kc deviation upper limit. Correspondence with

WRE brought an emphatic confirmation of their request. It was then assumed that these sync frequencies were to be used to sync the optical data to other range data, inasmuch as they were beyond the 40kc linear range of the discriminator.

These areas were pointed out in the November monthly report BEC-4278-M5. A message containing a brief description of the decommutating system has been of assistance; however, much is left open to discussion. A deeper reading into this much discussed portion of the specifications has again altered our approach.

At present, the commutated data track will include a 60kc ±25kc VCO. This will allow a recording capability of 35kc to 85kc. Data will be contained within 35kc to 65kc. 35kc represents 5 volts, where as 65kc represents 0 volts. 85kc will be equivalent to minus 3.333 volts. The crystal has been eliminated for the sync frequencies because of the addition of the wide band VCO.

In order to make the instrumentation compatible with the recording system, it has been necessary to design and build a suitable dc buffer amplifier for this interface. To provide an amplifier with low drift problems and high reliability, a chopper stabilized dc amplifier has been chosen.

In order to monitor the input to the VCO, a stepping switch has been included in the commutator so that by

disconnecting the logic network and manually stepping the main commutator, it is possible to observe selected data channel output. If it is desirable to observe a subcommutated channel, then all that is necessary is to step the main commutator until channel two is observed. When this occurs, the subcommutator channels will appear. By manually stepping the subcommutator switch, it is possible to select a desired subcommutator channel. If all channels are to be monitored, then this is possible by taking the output of the summing amplifier and display them on an oscilloscope; a dual trace scope is provided so that the signal into the commutator and the signal out of the discriminator may be monitored simultaneously. This provides a means of checking the system throughout when calibrating or troubleshooting should problems develop.

No decommutation electronics has been provided. The procedure described here mearly provides a quick means of determining the operational status of the multiplex system.

At the present time the first of the two systems is awaiting acceptance tests by BEC technical representatives at DCS. This will not be the final sign-off, but mearly a preliminary acceptance so that the unit can be delivered to BEC for instrument interface.

2.4 High Resolution Camera:

Early in the program shortly following the placement of the purchase order for the 70mm Flight Research camera and the 80-inch Jonel lens, there became available from Flight Research a camera which met our specifications with the following exception. The camera was equipped with a dynamically variable shutter. This made it possible for the shutter to be opened or closed while the camera was in operation. At the present time this is actuated mechanically by hand. However, it was purchased so that in the future, a photomultiplier package could be added to make this automatic. This will be very effective against targets where the intensity varies over a wide dynamic range. A low intensity target would be observed with a wide open shutter. As the target increased in intensity, the shutter would be stopped down by information sent to it by the photomultiplier package so that the intensity of the target on the film would not saturate the film. This automatic package can be provided at a later date. This feature was on an existing camera which was able to be purchased at a reasonable saving. This in itself was justified but at that time it was expected that this would also provide a saving on delivery time of the camera/lens package. The camera itself was received three to four weeks prior to the original delivery schedule but problems encountered by

Ransom Laboratories with the optics has delayed receipt of this complete package approximately eight weeks beyond the original delivery date. Delivery is now scheduled for the second week of January.

2.5 Disposition of Surplus Nike-Ajax Equipment:

Property representatives of BPD visited Barnes in October to decide the disposition of this equipment. At that time, it was stated that approximately eight weeks would be required to determine what sub units removed from the main consoles could be used on this program. We have at this time a listing of removed items which tabulates the quantity, official nomenclature, contractors nomenclature, and remarks relating to this. During our discussions with BPD, we were unable to decide whether it would be worth salvaging any of this equipment or to declare all of the surplus as scrap. We believe, that declaring this as scrap would be a desired approach. We will contact BPD in the near future for final disposition of this equipment.

2.6 Range Support Requirements:

A report covering the requirements for range support has been submitted to WRE through the AMICOM Contracting Officer. This includes a suggested site arrangement that could be constructed prior to the arrival of the optical systems at the Woomera Range.

Correspondence has been received from Mr. P.V. Moran, WRE, covering comments on the requirements. It was also suggested that the proposed meeting of interested persons at Salisbury, fall in late February and early March. This meeting must certainly take place well in advance of delivery so that preparations can be made at the Range to insure a speedy and orderly installation and checkout phase.

Since technical personnel concerned with these discussions would be the key personnel on the integration and checkout of the two optical systems at BEC, it may be well to suggest that the meeting be held in the United States. This would require several days as compared to the 10 to 14 days that would be necessary if the meeting were held at Salisbury, Australia.

Mr. Moran also felt that since a contract had not been signed between AMICOM and WRE, it would be embarassing if the meeting in February were not to materialize. WRE has a considerable amount of work to do in preparing the two site locations for the optical and radar systems. It

is very likely that decisions made in March would not allow adequate time for the facilities at Woomera to be completed at the time these systems are to be delivered. We feel that it would be desirable at this time if the contracting agency would advise the contractors as to whether the delivery date we are striving for is a realistic date from their standpoint.

3. SCHEDULE

The elevation carriage pattern was to be completed by the pattern maker and checked by Barnes Quality Control personnel the last week of November. The pattern was not completed, checked and delivered to the foundry until the third week of December. The first casting will be ready for inspection the first week of January. If the x-rays show no internal structural deficiencies, then the unit will be ready for machining. Three units are to be cast and machined. One to provide a back up should some unforseen damage occur to one of the other two, such as an off center bore through the shaft housing. Machining will require four to five weeks.

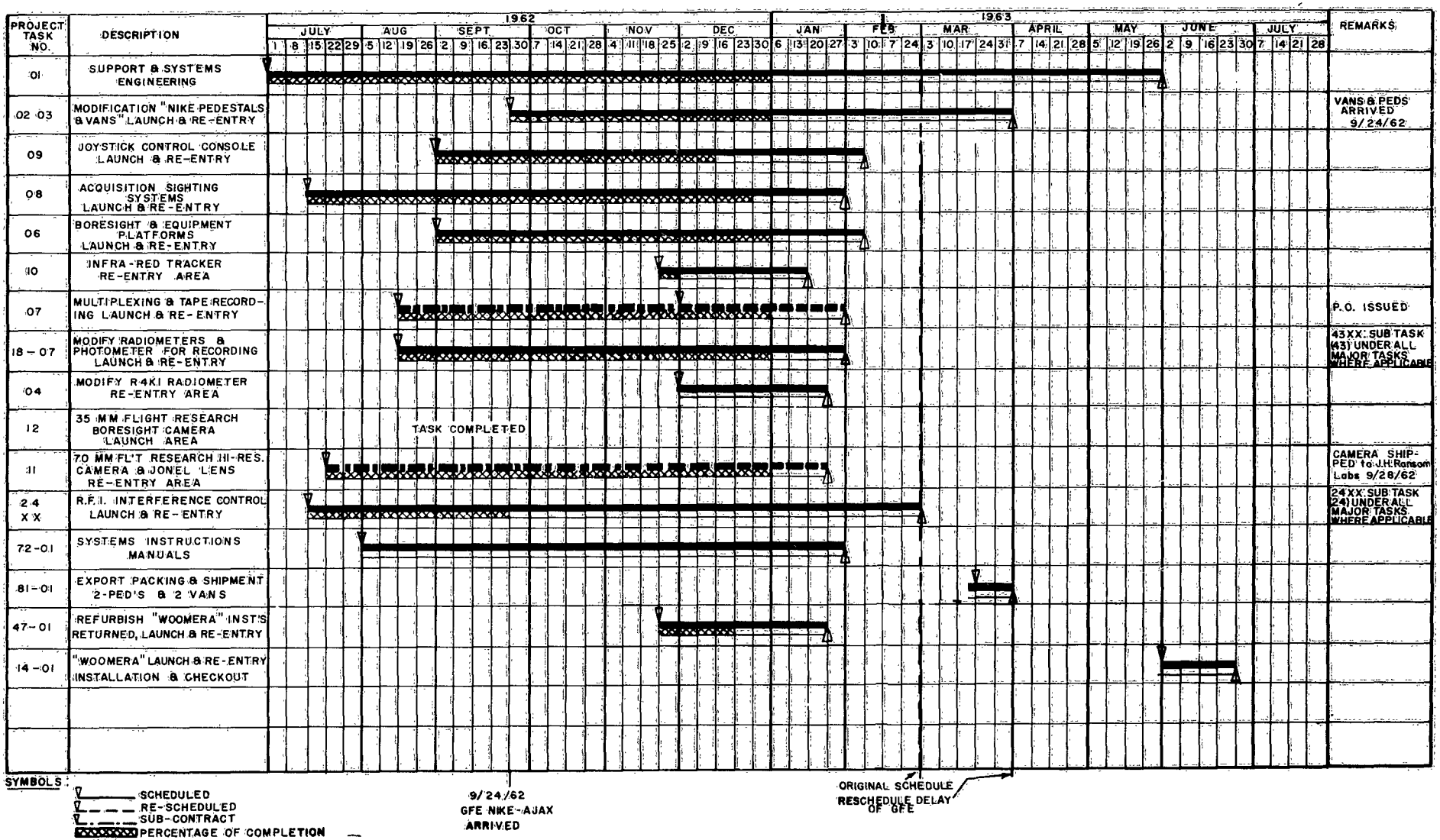
Should the x-rays indicate an unsound casting, than pouring a fourth or fifth casting would require an additional two to three weeks. Taking these possibilities into consideration, it is anticipated that the first machined elevation carriage with fitted shafts will be lowered into the trunnions of a pedestal by the third week of February.

The castings for the acquisition sight housing are scheduled to be received the second week of January. All machined components for the sight are scheduled in the fourth week of January.

Major components for the joystick control will be received by the last week of January. All components,

including the machined casting for the joystick console, are expected by the third week of February.

The Master Schedule, Figure 1, shows the updated schedule and progress in the various tasks. We are still striving for a March 31 delivery.



B0045-001

FIGURE 1 MASTER SCHEDULE BLACK KNIGHT RE-ENTRY PHYSICS PROGRAM WOOMERA AUSTRALIA BEC
PROJECT NO. 4278 AMICOM/BPD-DA19-020-ORD-5703

SEMI-ANNUAL PROGRESS REPORT SA-1 DECEMBER 1962

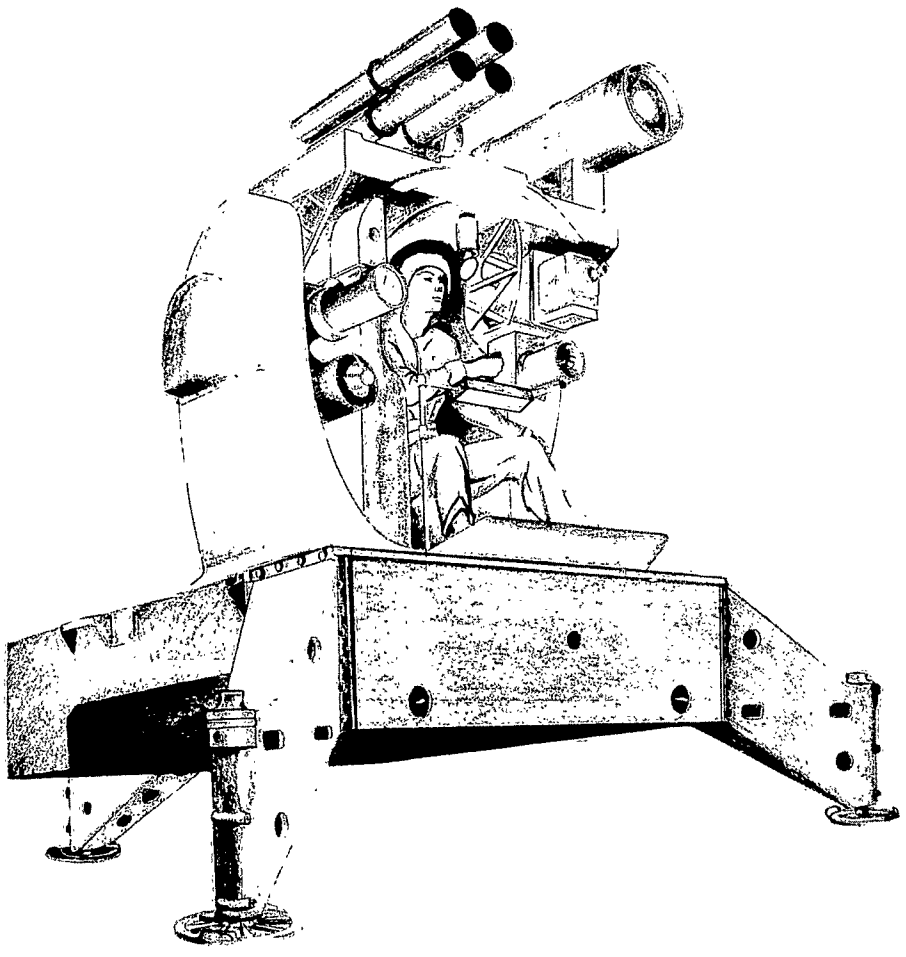


Figure 2 PEDESTAL PICTORIAL VIEW

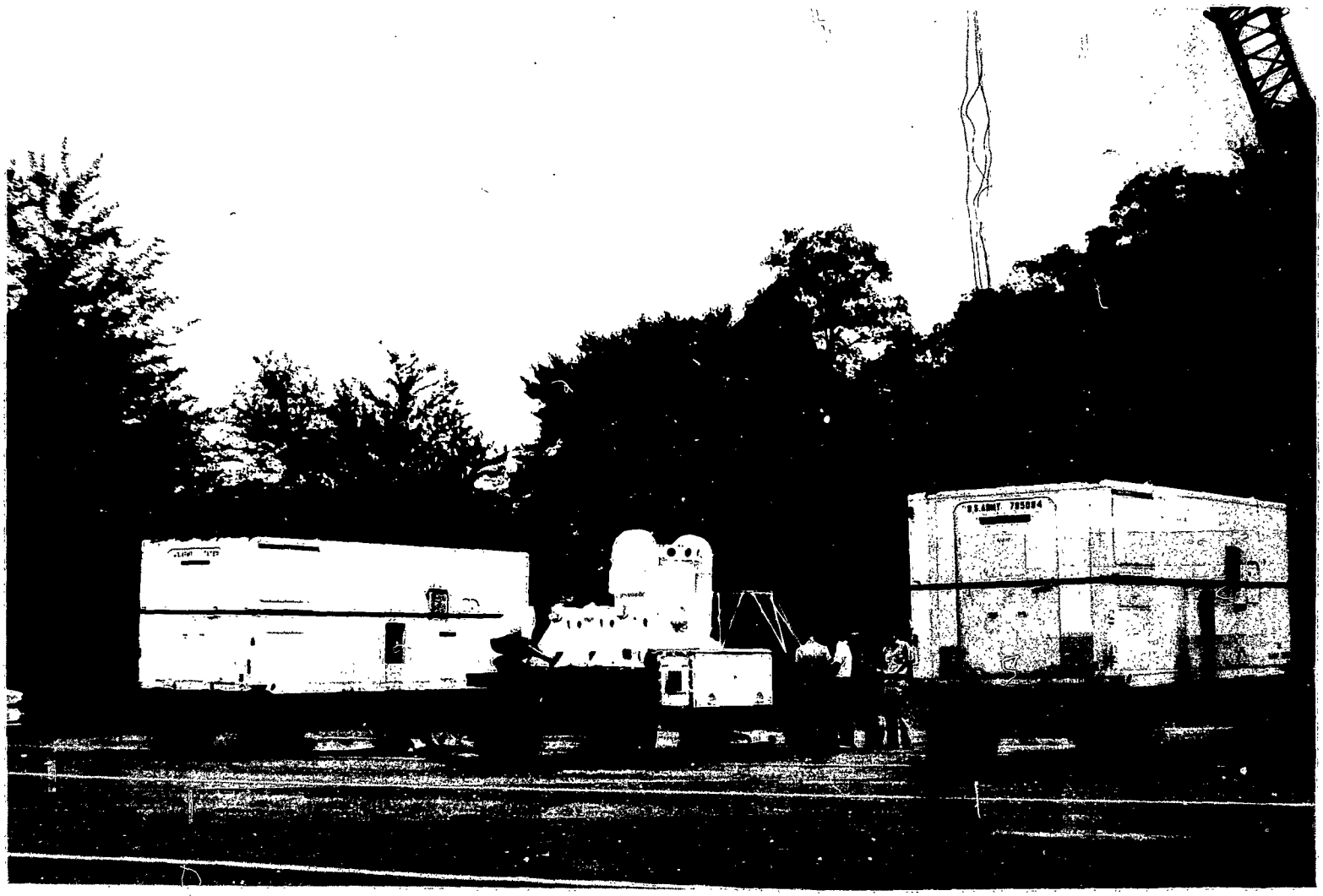
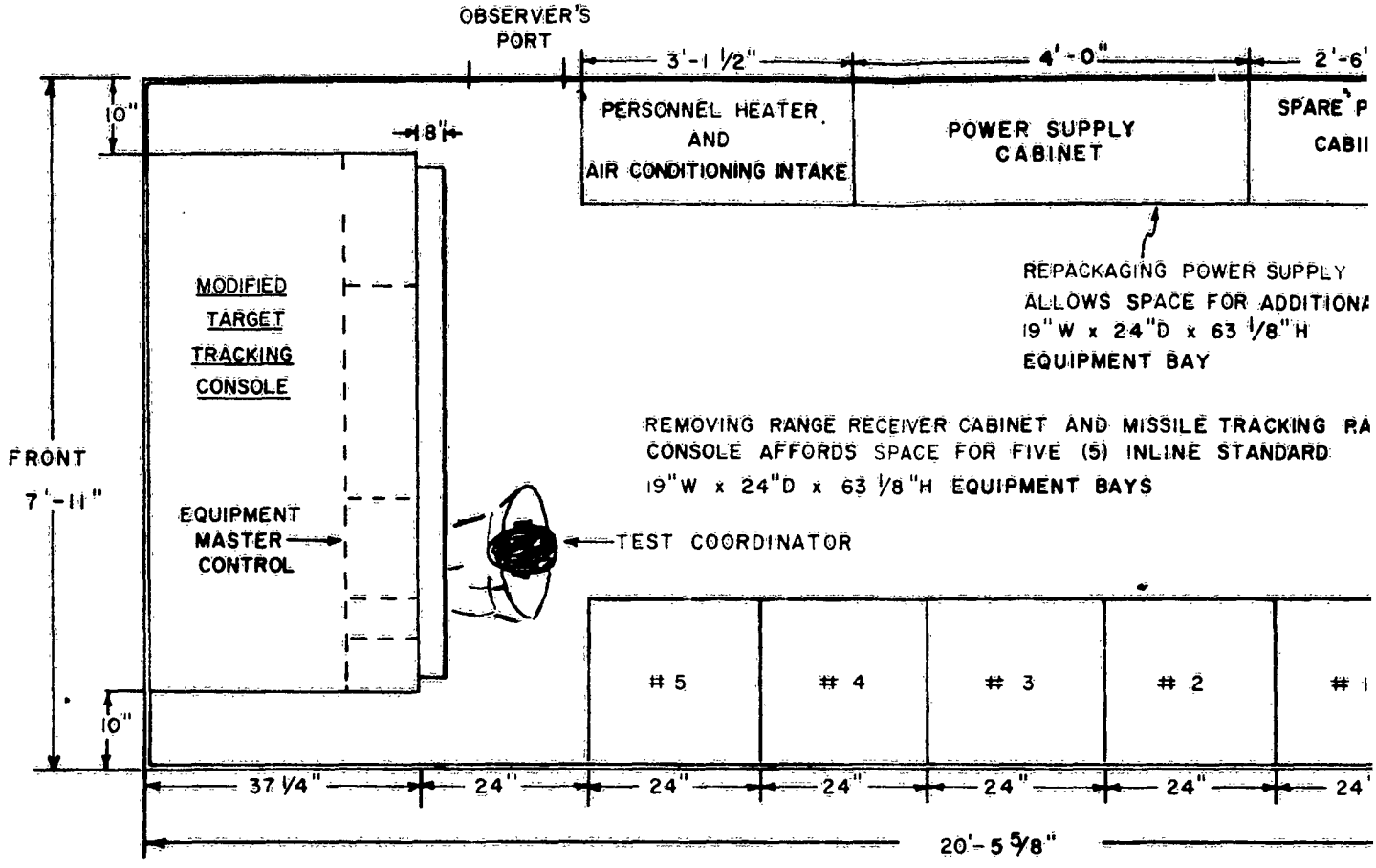


FIGURE 3 RC VANS AND TTR PEDESTAL UPON DELIVERY TO BARNES

PLAN VIEW OF VAN



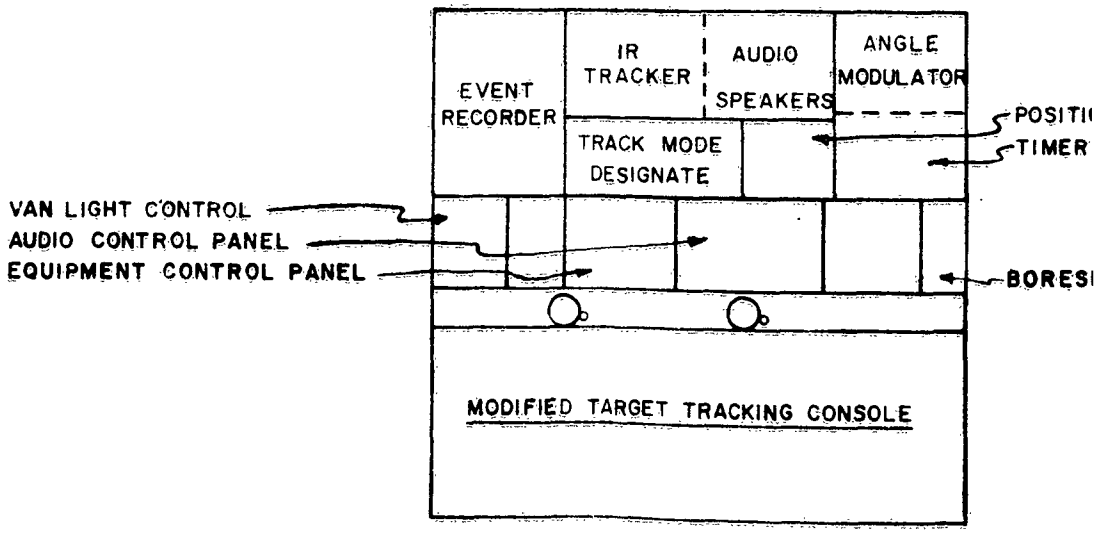
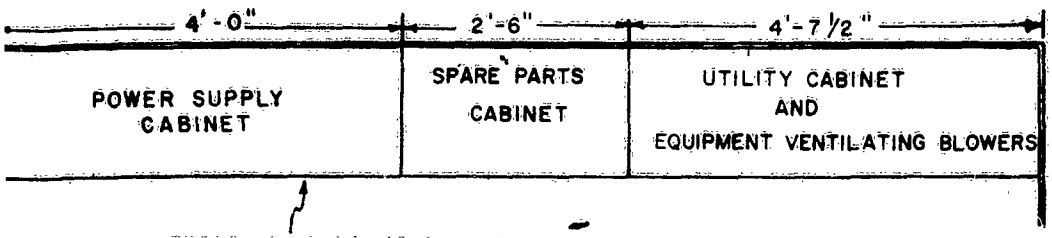


FIGURE 4

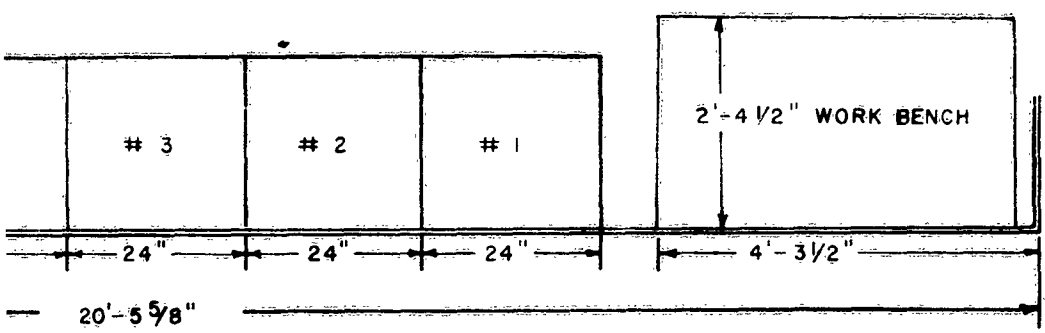
AN VIEW OF VAN



REPACKAGING POWER SUPPLY
ALLOWS SPACE FOR ADDITIONAL
19"W x 24"D x 63 1/8"H
EQUIPMENT BAY

ECEIVER CABINET AND MISSILE TRACKING RADAR
SPACE FOR FIVE (5) INLINE STANDARD
1/8"H EQUIPMENT BAYS

REAR



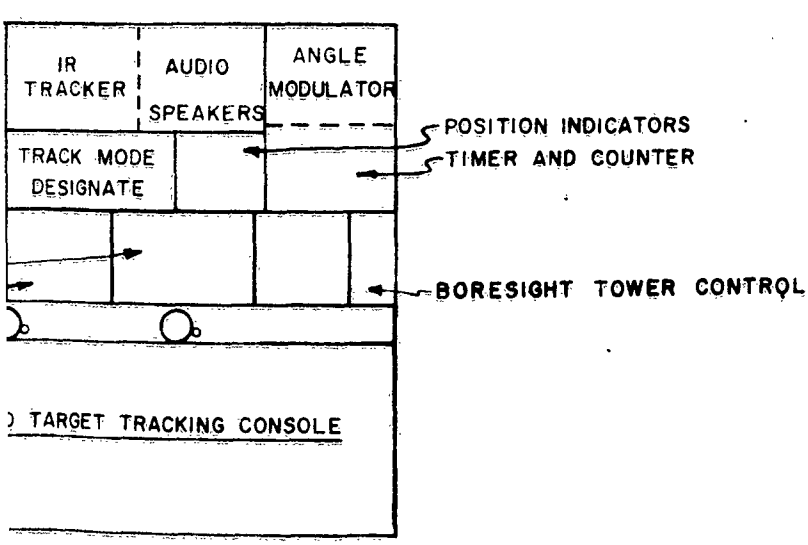


FIGURE 4

B 0045-007

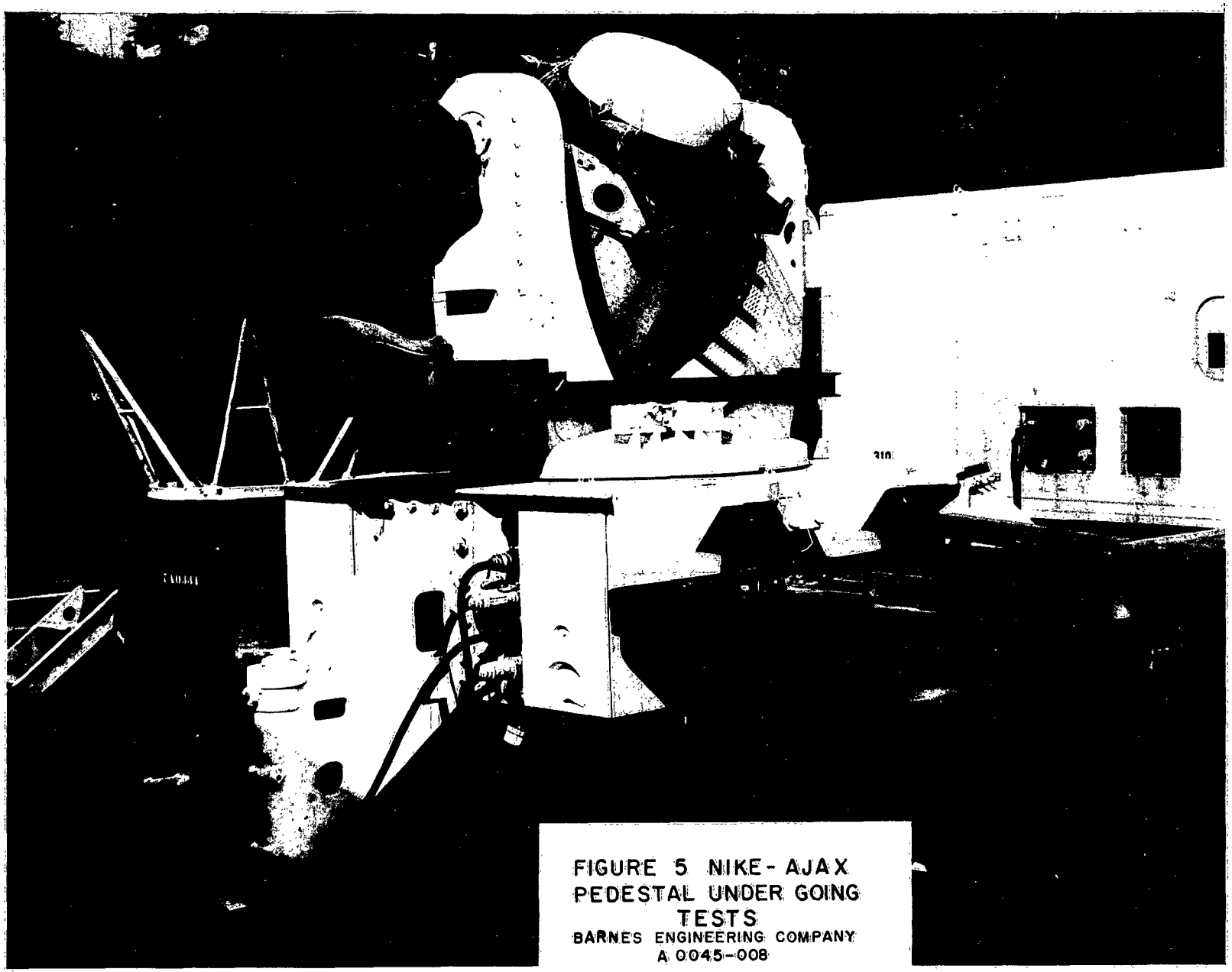


FIGURE 5 NIKE-AJAX
PEDESTAL UNDER GOING
TESTS
BARNES ENGINEERING COMPANY
A 0045-008